CLUB LEADER

STEM Club

LET'S EXPLORE THE UNIVERSE TOGETHER!

ACTIVITY DETAILS

RESOURCE LISTS

LEARNING OUTCOMES

PROUD TO BE PART OF

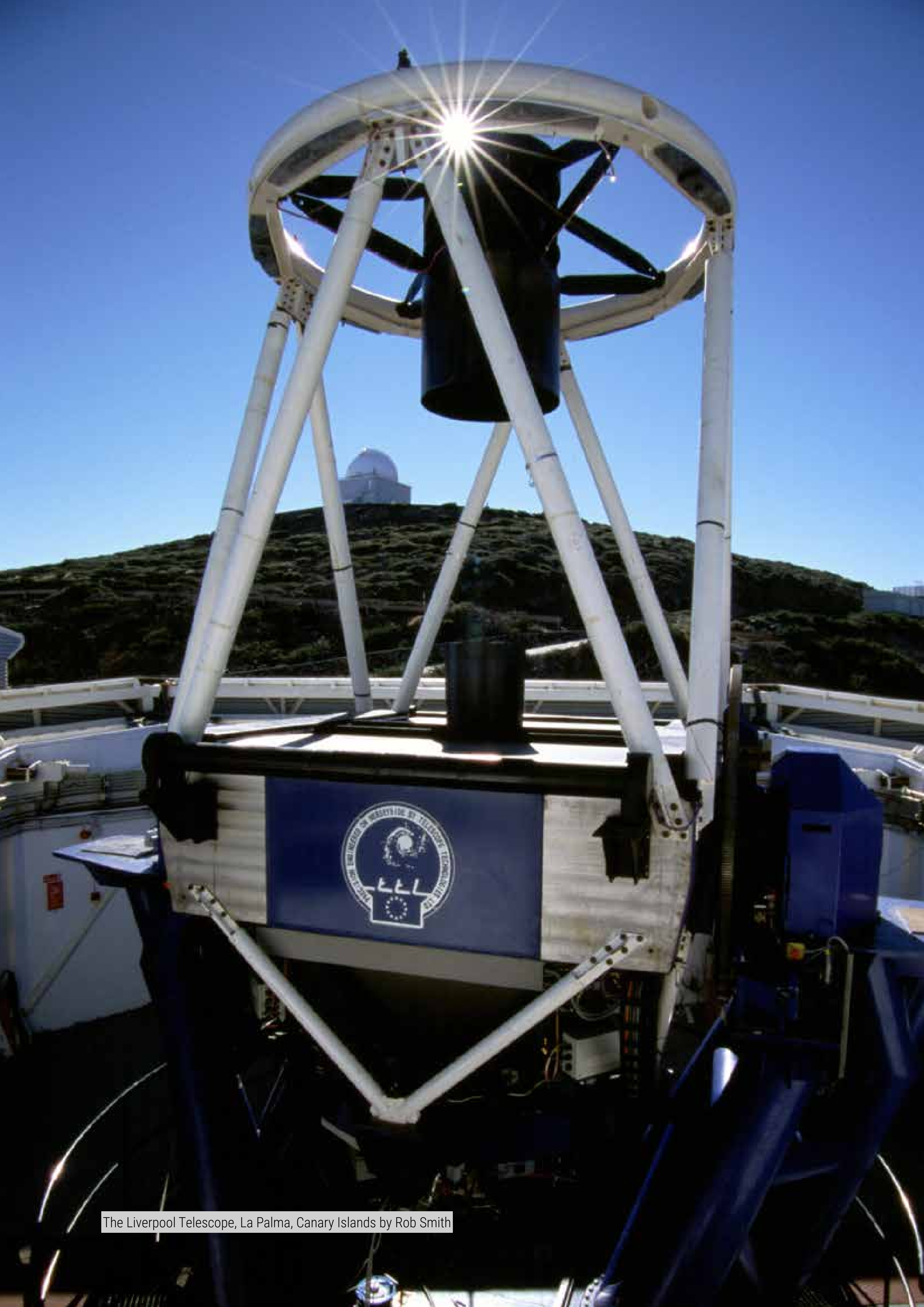
LIVERPOOL JOHN MOORES UNIVERSITY

Arp 142: The Penguin and the Egg by NASA-ESA/STScI/AURA/JPL-Caltech

SILVER

PRIMARY EDITION

THE SCHOOLS' OBSERVATORY



The Liverpool Telescope, La Palma, Canary Islands by Rob Smith

CONTENTS

Primary STEM Club - Silver Award - Club Leader Edition

The Eagle Nebula by The Schools' Observatory

INTRODUCTION

The Schools' Observatory (TSO) is passionate about inspiring the next generation of scientists, programmers, engineers and mathematicians. We provide free access to the world's largest fully robotic telescope, and use the wonders of space to excite and amaze pupils of all ages and develop their love of STEM education.

What is The Schools' Observatory STEM Club Program?

This STEM Club programme provides three levels of activities; Bronze, Silver and Gold. Each level takes six weeks to complete. The activities are designed to take around an hour each week and can be run by someone with little-to-no science background, making them ideal for a parent, teaching assistant or even an older pupil.

The programme includes two resource booklets and a series of supplementary documents, hosted on www.schoolsobservatory.org/stem-club. The STEM Club Leader booklet (this booklet) provides guidance notes on the activities, and details the resources and knowledge needed to successfully and easily run each session. The pupil booklet contains step-by-step instructions for each activity and spaces for pupils to record their work throughout the programme. The pupil booklet forms their individual record of achievement as they progress through the levels.

How To Use This Booklet:

This booklet contains six sessions. Each session will briefly explain the pupil activities, list the necessary resources you'll need and contains additional useful information, such as facts or web links. It will also give learning objectives for the session and provide any answers if relevant.

It would be useful to have your own copy of the pupil booklet to help you plan and deliver the sessions.

What Happens On Completion?

Once you have finished this STEM Club level you can download a certificate for your pupils from our website. Full details can be found on page 31 of this booklet.

ABOUT THE BOOKLETS

Both the STEM Club Leader and pupil booklets use the same style and formatting. This page contains a full set of examples.

1. Activity steps are numbered like this

WARNING

Warning notices are used to remind pupils to be careful when completing the activity.

ADDITIONAL

Information in these boxes is at a slightly more advanced level. It is not essential for completing the activity but is there to stimulate a more advanced or older pupil.

Full resource lists are included. The tables refer to materials needed per group e.g.

REQUIRED RESOURCES
☆ One piece of A4 paper
☆ One pencil

It would be great if you tagged us on any social media posts **@SchoolsObs.**

This is a tip. Useful information will be written like this to help it stand out from the activity steps.

SESSION 1: DAY AND NIGHT

In this first session the pupils will be using a ball of Play-Doh and a torch to discover for themselves how the rotation of the Earth causes day and night. They will also create their own sundial to tell the time.

ACTIVITY 1: CREATE YOUR PLAY-DOH EARTH

Learning Objectives, pupils will learn:

1. what causes day and night
2. how the Earth spinning gives night and day
3. how the Earth spins on its axis

Each group will require the following:

REQUIRED RESOURCES
☆ Torch
☆ Globe
☆ Play-Doh
☆ Pencil

During the session:
Talk to the pupils about the Sun, explain that the light we receive comes from the Sun. It takes around 8 minutes for the light to travel from the Sun to us on Earth. Explain to them how we get day and night. They may believe that night and day is due to the Sun/Moon moving, as this is what appears to happen by looking at the sky. Explain that the Sun remains stationary but the planets in the Solar System orbit the Sun. It is the Earth that is moving, not the Sun.

The ball of Play-Doh will represent the Earth and the torch will represent the Sun.

Each pupil should record their investigation by drawing and labelling four diagrams (or photographing their Play-Doh Earths), showing the position of their location marker at each of the following times: Sunrise, Midday, Sunset, Midnight.


Simulated Sunrise by TSO


Simulated midday by TSO


Simulated Sunset by TSO


Simulated midnight by TSO

Useful Information:
The Sun doesn't actually move. It is the Earth rotating that gives the appearance that the Sun is moving across the sky.

Answers:

Q1. How long does it take for the Earth to make one full rotation?
A1. 24 hours

Q2. Why does the Sun appear to move across the sky?
A2. Because the Earth rotates on its axis.

Q3. In which direction does the Sun appear to rise in the morning?
A3. East

Q4. In which direction does the Sun appear to set in the evening?
A4. West

Q5. If it is daytime in your country, name a country where it is night time.
A5. Appropriate countries will be on the opposite side of the globe. e.g. Europe/ Australia, China/South America, USA/Indian Ocean

Nightfall across Europe and Africa by NASA

ACTIVITY2: SUNDIALS

During this session the pupils will make their own sundials in order to consider how shadows are cast, how they change when the light source is moved and how the Sun can be used to tell the time.

Learning Objectives, pupils will learn:

1. how blocking light creates shadows
2. to understand how a sundial can be used to tell the time with the Sun

Before the session:
*There are three sundial worksheets on pages 9, 10 and 11. Choose the location nearest to you: London, Manchester or Edinburgh. If you want to create printable sundials for your exact location, you can use this online tool:
www.blocklayer.com/sundial-popeng.aspx

The Schools' Observatory does not endorse this website. The link worked at time of publishing. Other sites may be available.

WARNING

Remind the pupils to never look directly at the Sun as it can damage their eyes.

Each group will require the following:

REQUIRED RESOURCES
☆ Printed sundial worksheet*
☆ Scissors
☆ Glue sticks/sticky tape
☆ A compass**
☆ Enough sunlight to make shadows

**If you do not have access to a compass, you can download free compass apps to a smartphone to help you find north.

During the session:

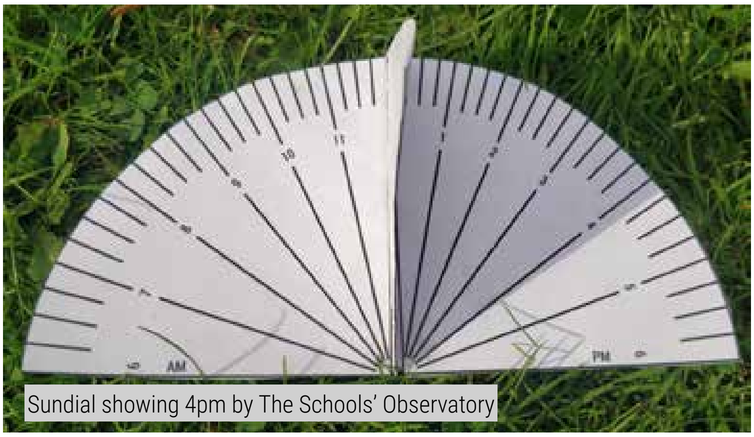
1. **Explain how shadows are cast:**
   Shadows are created when an object, such as a tree or your body, blocks out some of the Sun's light. Light travels in straight lines so it can't get around the object that is in the way.

   The length of the shadow created depends on how low or high the Sun is in the sky. Remember the Sun appears to change its position in the sky because the Earth is rotating. If it is close to midday, the Sun will appear high in the sky and shadows will be at their shortest. Shadows are longer in early morning or late afternoon when the Sun appears low in the sky, close to the horizon.

   As well as the time of day, the season affects shadows. Winter shadows are longer than those created during the summer, because the Sun is lower in the sky.

2. **Introduce the idea of sundials and how they use the rotation of the Earth on its axis to create a moving shadow that can be used to tell the time.**
   Sundials work by casting a shadow. The position and length of this shadow changes as the day goes on, because the Earth is always turning. The sundial splits the day into segments numbered with the hours of the day. As the shadow travels over these segments, it tells you (roughly) what time it is.

3. **Give the pupils their sundial worksheets.**
   They will need to follow the instructions in their booklets: cut around the outer edge of the sundial, then fold the centre vertical line up and the two 'True North' lines down to create a triangle. This is called the Gnomon. To make sure the sundial keeps its shape they can glue the insides of the triangle together.



Sundial showing 4pm by The Schools' Observatory

4. Once the pupils have all finished making their sundials, take them outside to try out their sundials (if it is too cloudy, or night time, you could simulate the Sun using a large torch).They will need to position the sundial to north. They should now be able to tell the time using their sundials!

5. In their booklets, the pupils should then either draw or photograph their sundial and its shadow, and write down the time their sundial shows as well as the actual time.

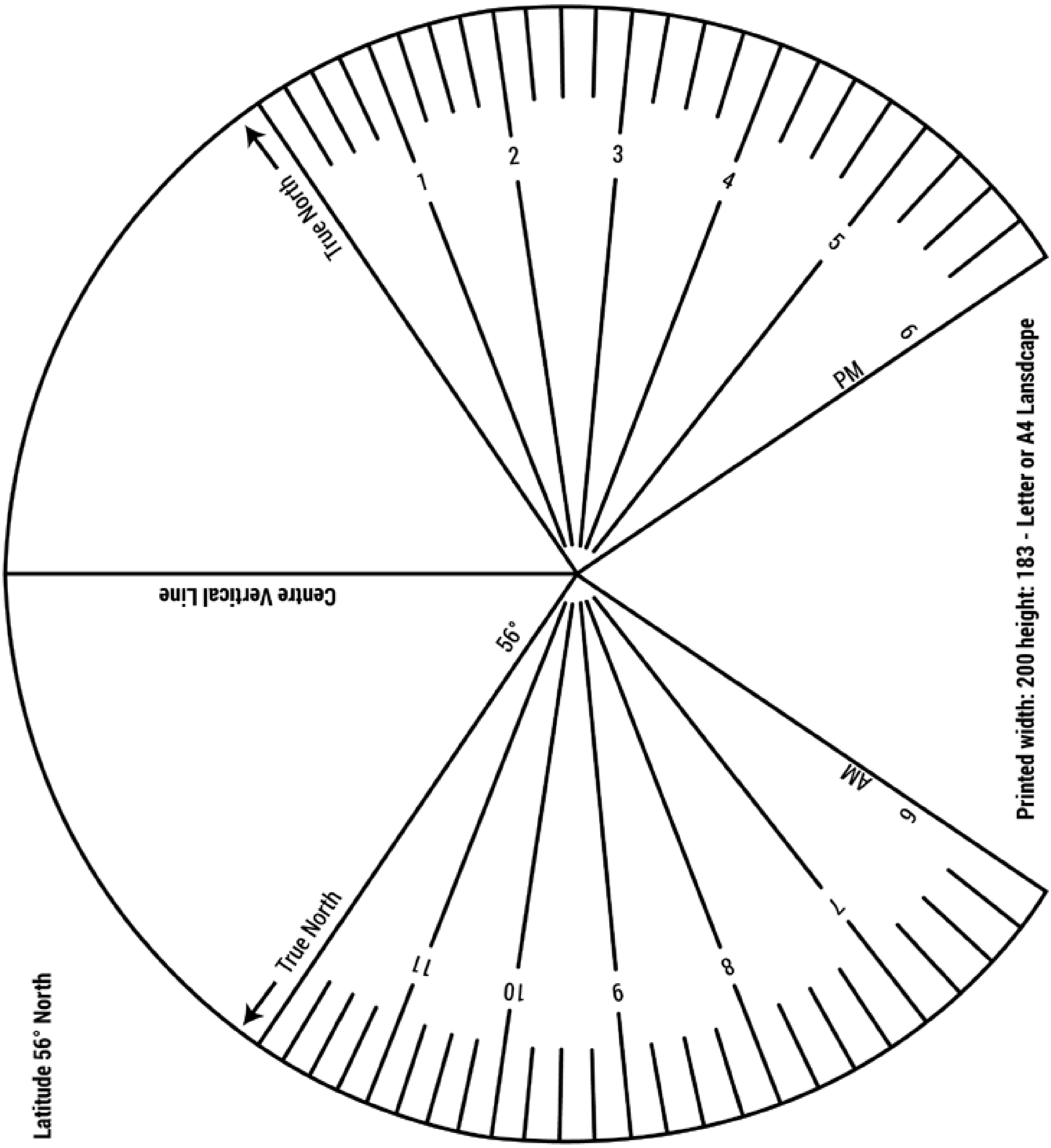
6. **Ask the pupils the following questions:**
   Q1. Why does the sundial create a shadow?
   A1. The Gnomon casts a shadow onto the sundial surface.

   Q2. Why does that shadow move throughout the day?
   A2. The Earth is rotating on its axis. The Sun appears to move across the sky.

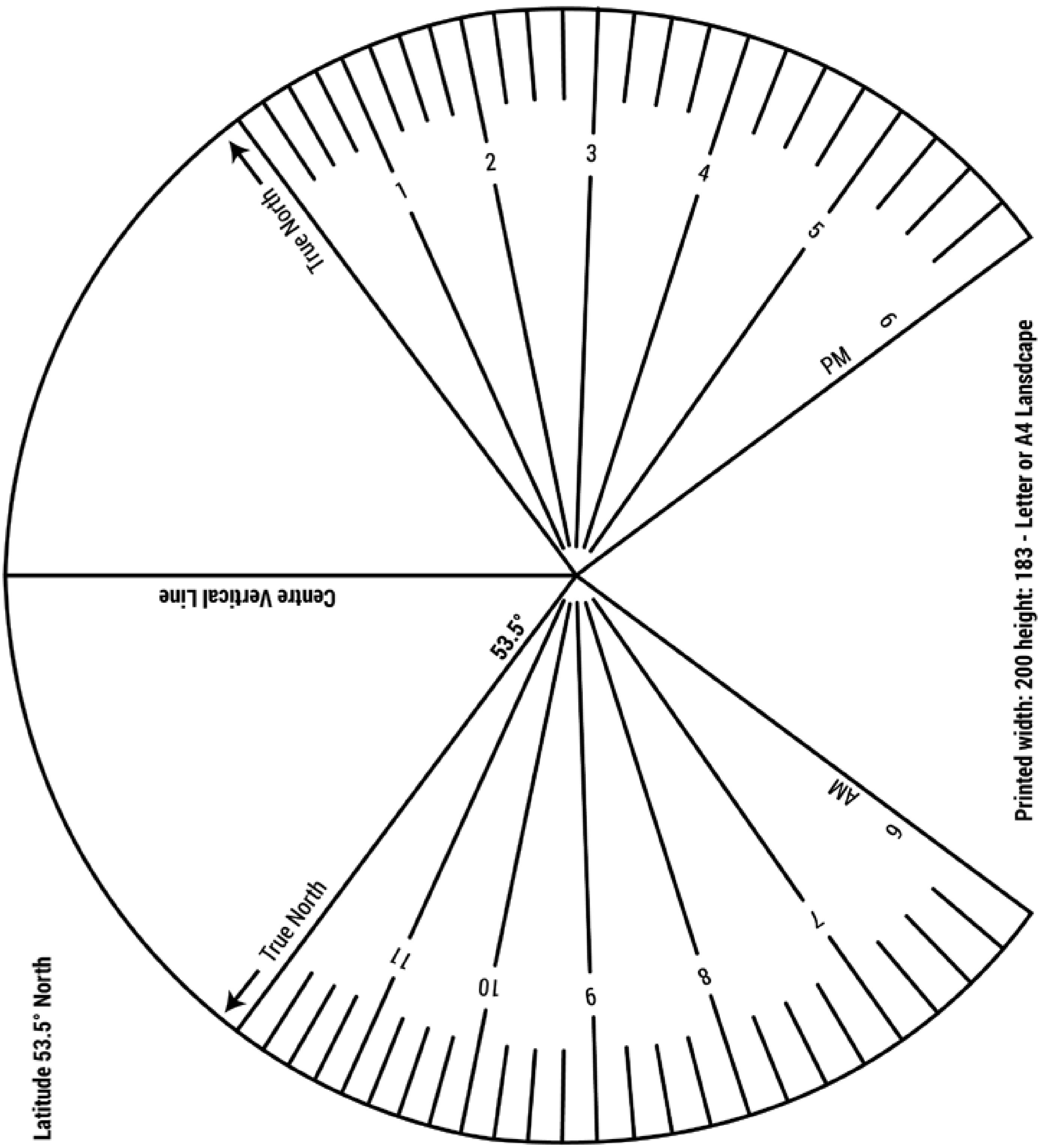
   Q3. What happens to the shadow if the light source (when using a torch) moves?
   A3. The shadow changes shape. Pupils may notice some or all of the following:

closer = sharper	**higher = shorter**
further = fuzzy	**lower = longer**

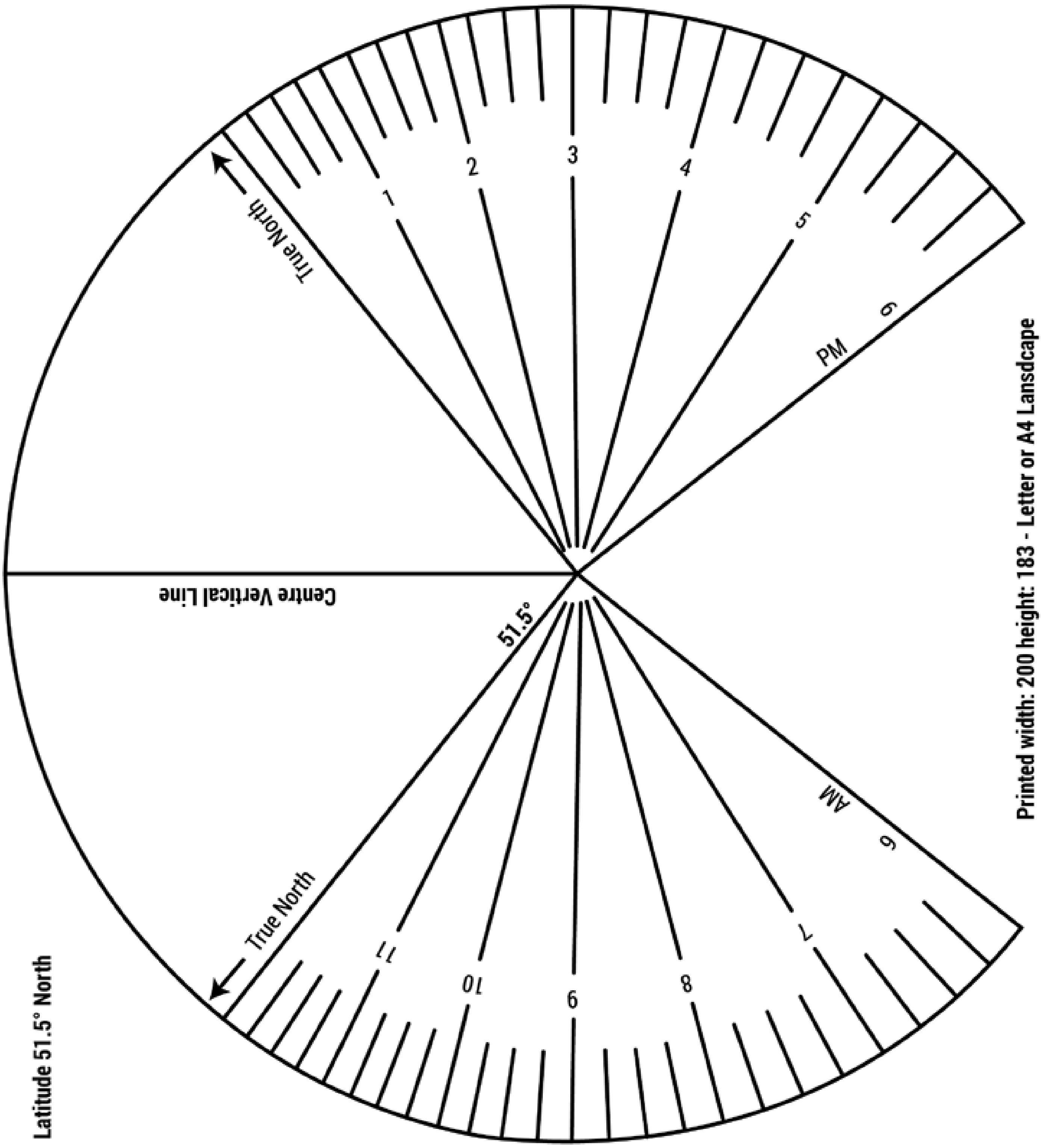
LOCATION: 56° NORTH - EDINBURGH



LOCATION: 53.5° NORTH - MANCHESTER



LOCATION: 51.5° NORTH - LONDON



SESSION 2: THE SUN

This week the pupils will be recreating a solar eclipse, learning about the different features on the Sun's surface, and building their own Sun from cookies and sweets.

ACTIVITY 1: SOLAR ECLIPSE PHASES

You can recreate the phases of a solar eclipse using two discs of paper. Give the pupils a Moon cut-out to slide across the Sun printed in their booklets.

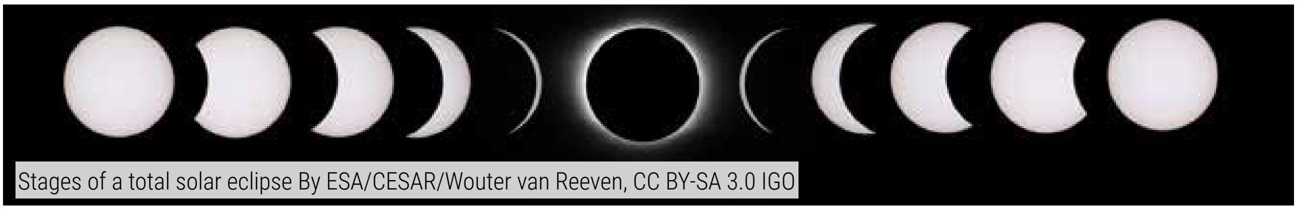
Learning Objectives, pupils will learn:

1. explain what a solar eclipse is
2. manipulate a model of a solar eclipse using cut-outs
3. notice how the shape of the Sun changes during a solar eclipse

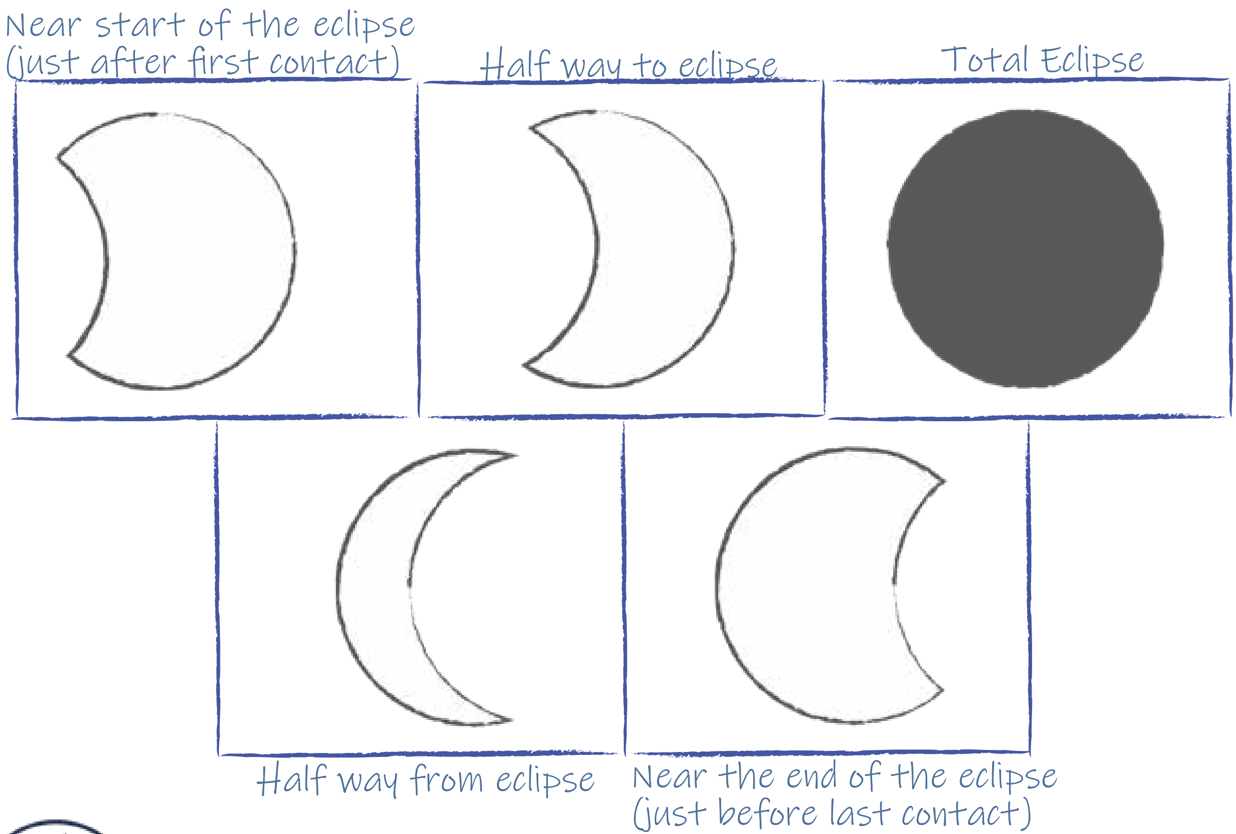
Each group will require the following:

REQUIRED RESOURCES
☆ A Moon cut-out

Before the session:
Cut out the moon templates (see page 13) or factor in time at the start of the session for the pupils to do this. You might want to show some images of the Sun together as a group to discuss them.

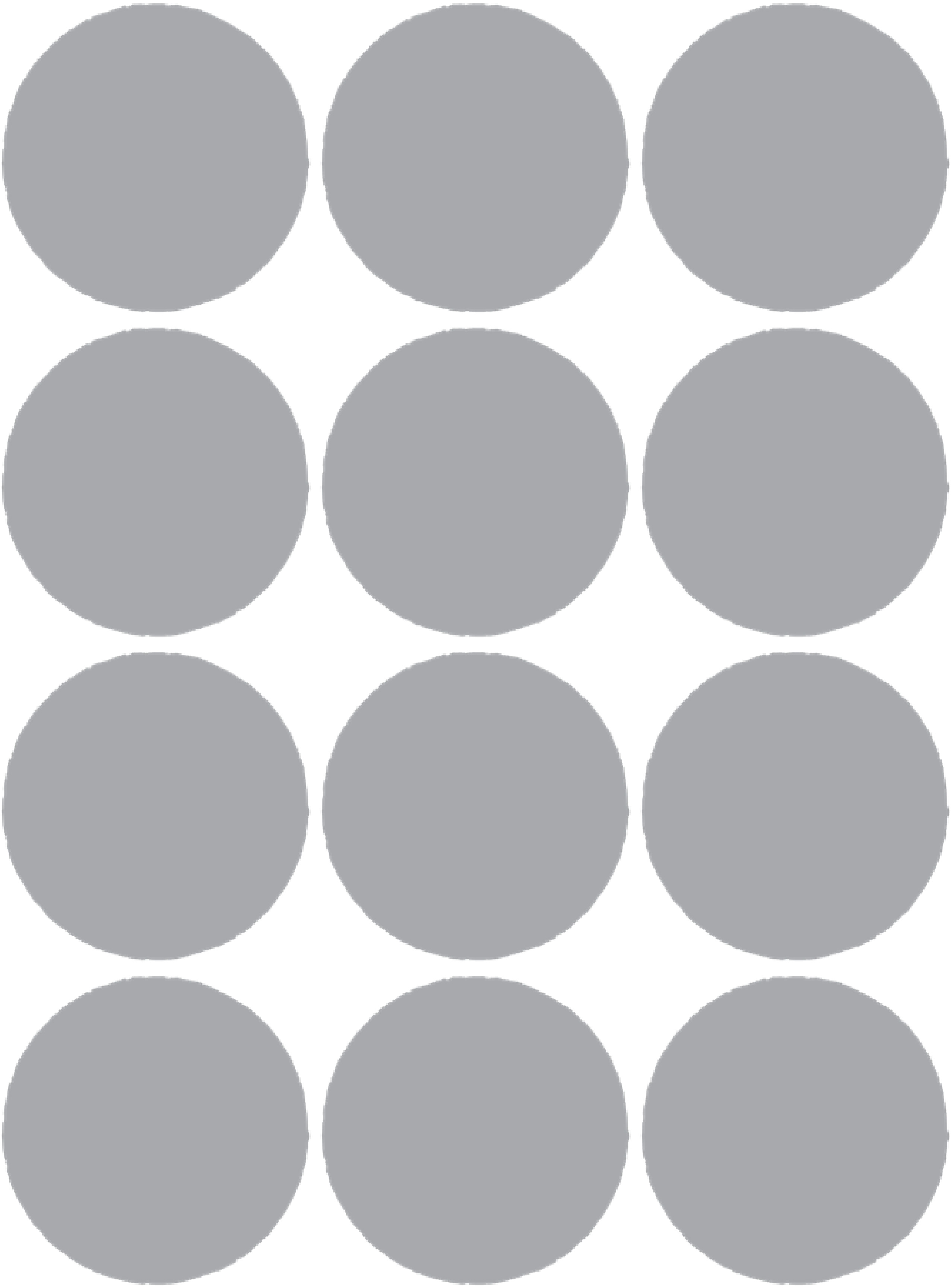

Stages of a total solar eclipse By ESA/CESAR/Wouter van Reeven, CC BY-SA 3.0 IGO

Answers will look something like this (their pictures may run left to right, or right to left)...



MOON CUT-OUTS

Photocopy this page as many times as you need and cut out the Moons. Alternatively there is a printable version available here: www.schoolsobservatory.org/stem-club



ACTIVITY 2: SOLAR COOKIES

Learning Objectives, pupils will learn:

1. to understand the Sun is a star
2. that astronomers observe different features and events on the Sun
3. to create an edible model of the Sun

Before the session:
Make sure you have the required resources. Check for any food allergies among the learners. Alternatively, you can create the Sun and solar features out of craft materials, instead of edible models.

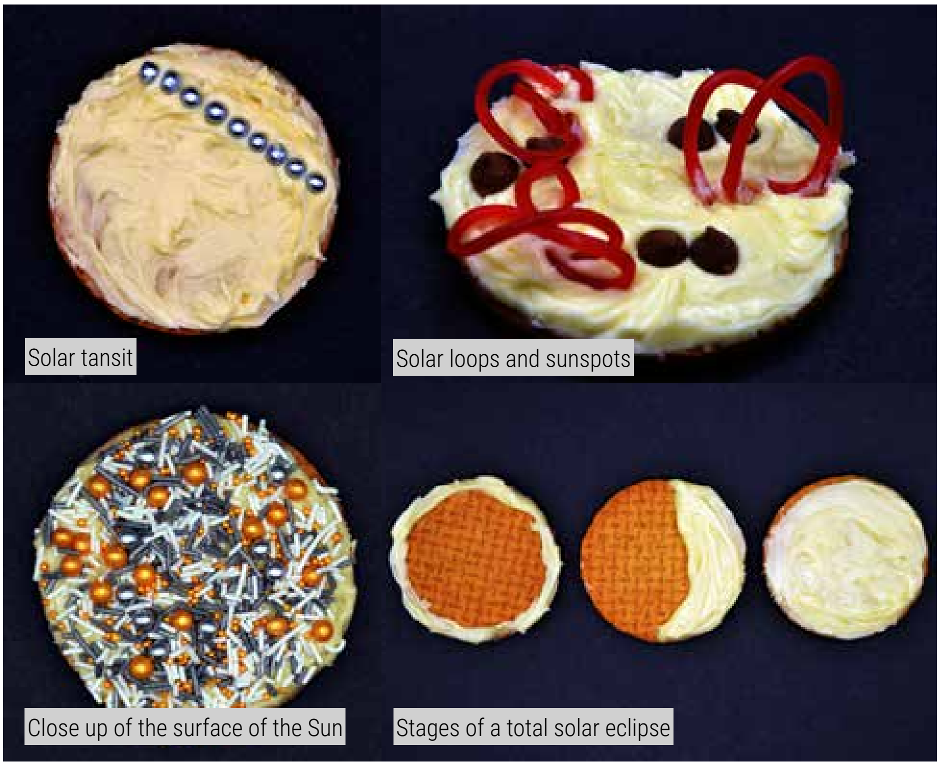
During the session:
Things might get a bit messy and if the pupils want to eat their cookies make sure they wash their hands first and there is a clean environment for them to get creative in!

We've included photos of some solar cookies. No two look the same! Encourage your group to interpret the Sun's features in creative ways. Once the pupils have finished designing their solar cookies, select a few pupils to present their cookie and describe the solar features they have included.

Each group will require the following:

REQUIRED RESOURCES
☆ Large cookies or biscuits
☆ Plates/board for decorating on
☆ Small spoons/knives/spreaders
☆ Small chocolate chips
☆ Strawberry laces (chunky are best)
☆ Scissors
☆ Vanilla/Lemon icing
☆ Sprinkles/Dragees
☆ Apron (optional - if getting messy)

Feel free to share your images of solar cookies on social media but please tag us so we can see them too!



Solar tansit

Solar loops and sunspots

Close up of the surface of the Sun

Stages of a total solar eclipse

SESSION 3: SPACE ART

This week the pupils will be taking inspiration from images of astronomical objects to create their own pieces of artwork using pastels.

Learning Objectives, pupils will learn:

1. how astronomers know what nebulae are made from based on the colours they see
2. that astronomers in the past called objects names based on what they looked like
3. how astronomy can be artistic

*The 3-Colour image examples can be downloaded for PowerPoint or a printable PDF version, or you can photocopy pages 17 to 19 in this booklet. Download from here: www.schoolsobservatory.org/stem-club

** to cut the paper to better fit inside their booklets.

Each group will require the following:

REQUIRED RESOURCES
☆ 3-Colour image examples*
☆ Black A4 paper/card
☆ Coloured pastels
☆ Scissors**
☆ Glue

During the session:
Show the pupils the six nebula images on pages 17, 18 and 19 (they also have smaller versions in their booklets). The names and basic information about each nebula are on the next page. Ask your pupils to guess what they were nicknamed by astronomers based on what they look like. Get them to write their guesses in the spaces provided on the images in their booklets.

Explain that nebulae are clouds of hot gas and dust. There is often a dying star, or some new-born stars within them that is making the gas glow. The colours of the nebula can provide clues to what material it is made from:

Green = Oxygen (third most abundant element in the universe)
Red = Hydrogen (the lightest of all elements and the most abundant).

On Earth, hydrogen combines with oxygen to form water, essential for life! After discussing the images with the group, ask the pupils to create their own nebula with a creative name. Provide pupils with black paper and pastels in a range of colours.

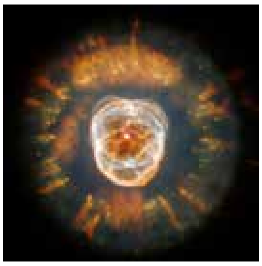
Useful Information:
You may want to demonstrate how to ‘blend’ and ‘smudge’ the pastels, particularly if the pupils have not used pastels before.

In order to stick their artwork into their own booklets, they may need to cut the paper to fit.

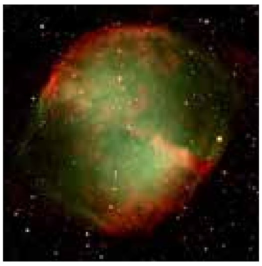
1) Cats Eye Nebula
Type: Planetary nebula
Location: Northern constellation of Draco
Discovered: 15th February 1786
Discovered by: William Herschel
Other names: NGC 6543, Caldwell 6
Snail Nebula
Sunflower Nebula

2) Butterfly Nebula
Type: Bipolar planetary nebula
Location: Constellation of Scorpius
Discovered: At least 1888
Discovered by: The earliest-known study is by Edward Emerson Barnard, who drew and described it in 1907
Other names: NGC 6302
Bug Nebula

3) Abell 33
Type: Planetary nebula
Location: Constellation of Hydra
Discovered: Unknown
Discovered by: Unknown
Other names: Diamond ring nebula



4) NGC 2392
Type: Bipolar double-shell planetary nebula
Location: Constellation of Gemini
Discovered: 1787
Discovered by: William Herschel
Other names: Clownface Nebula
Caldwell 39



5) Dumbbell Nebula
Type: Planetary nebula
Location: Constellation of Vulpecula
Discovered: 1764
Discovered by: Charles Messier
Other names: NGC 6853
Messier 27
Apple Core Nebula

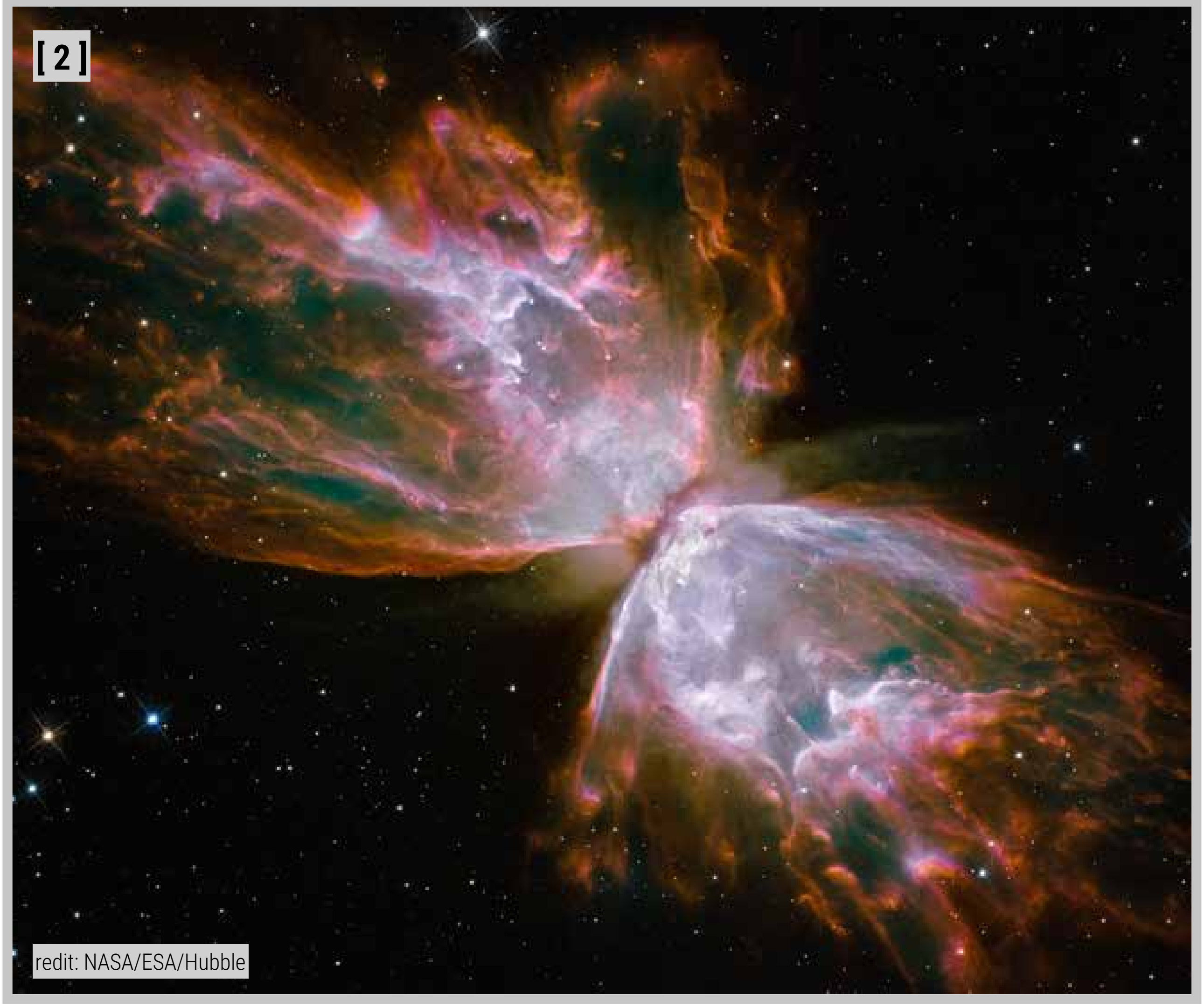
6) Bubble Nebula
Type: Emission nebula
Location: Constellation of Cassiopeia
Discovered: 1787
Discovered by: William Herschel
Other names: NGC 7635
Sharpless 162
Caldwell 11

On the front cover of this booklet you can also see an example of interacting galaxies, which looks like a penguin (NGC 2936) guarding an egg (NGC 2937)!

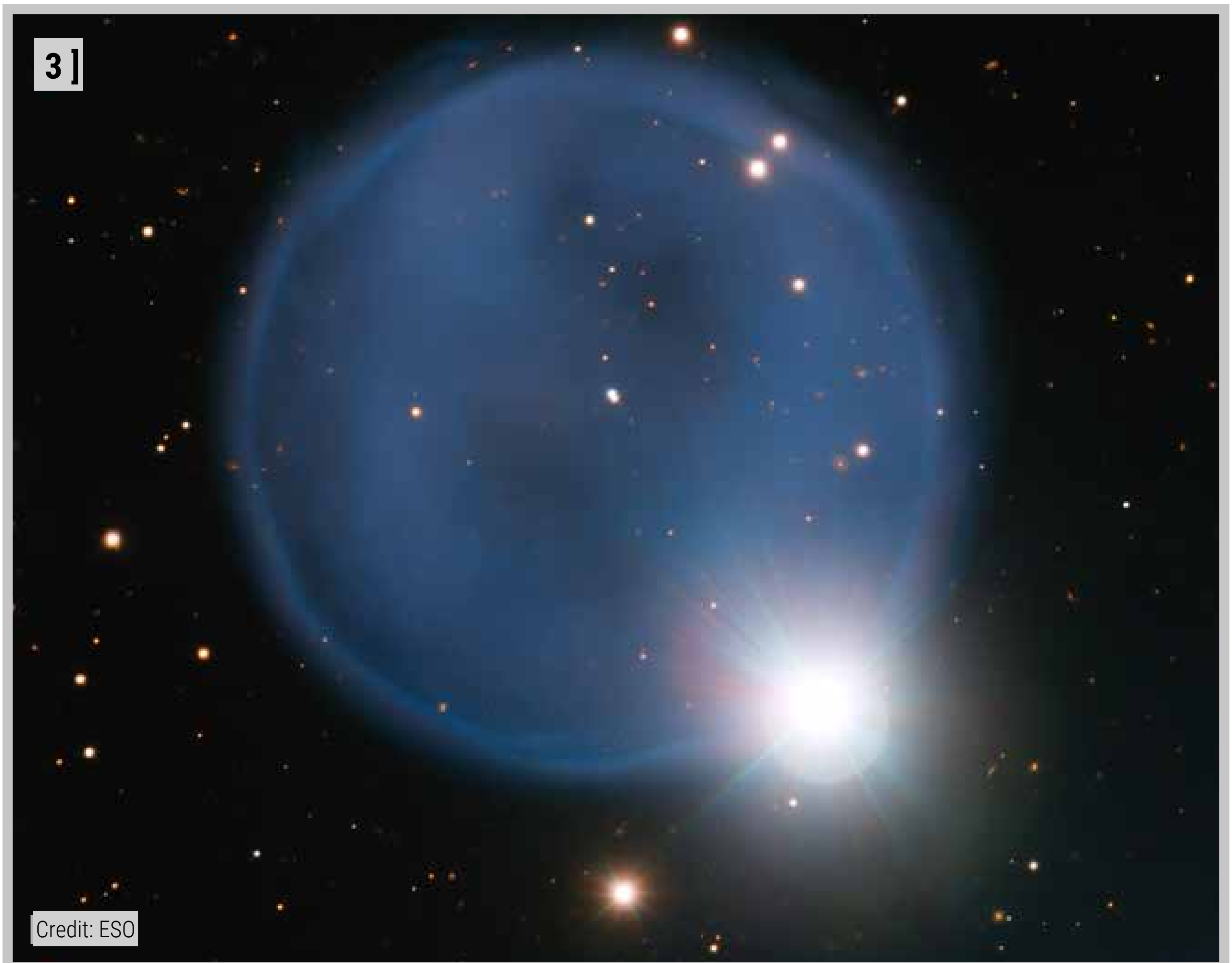
[1]

Credit: X-ray: NASA/CXC/SAO; Optical: NASA/STScI

[2]

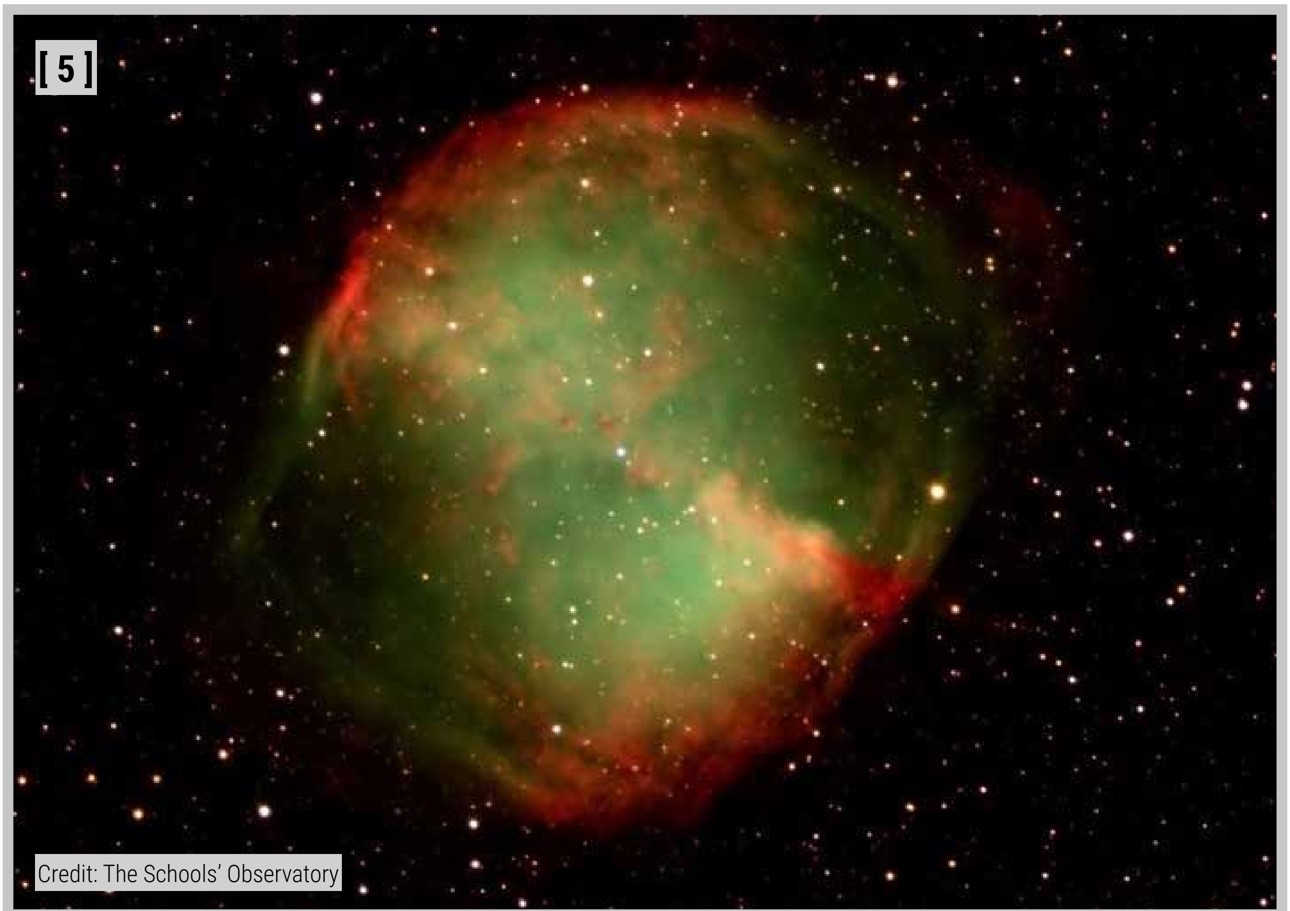


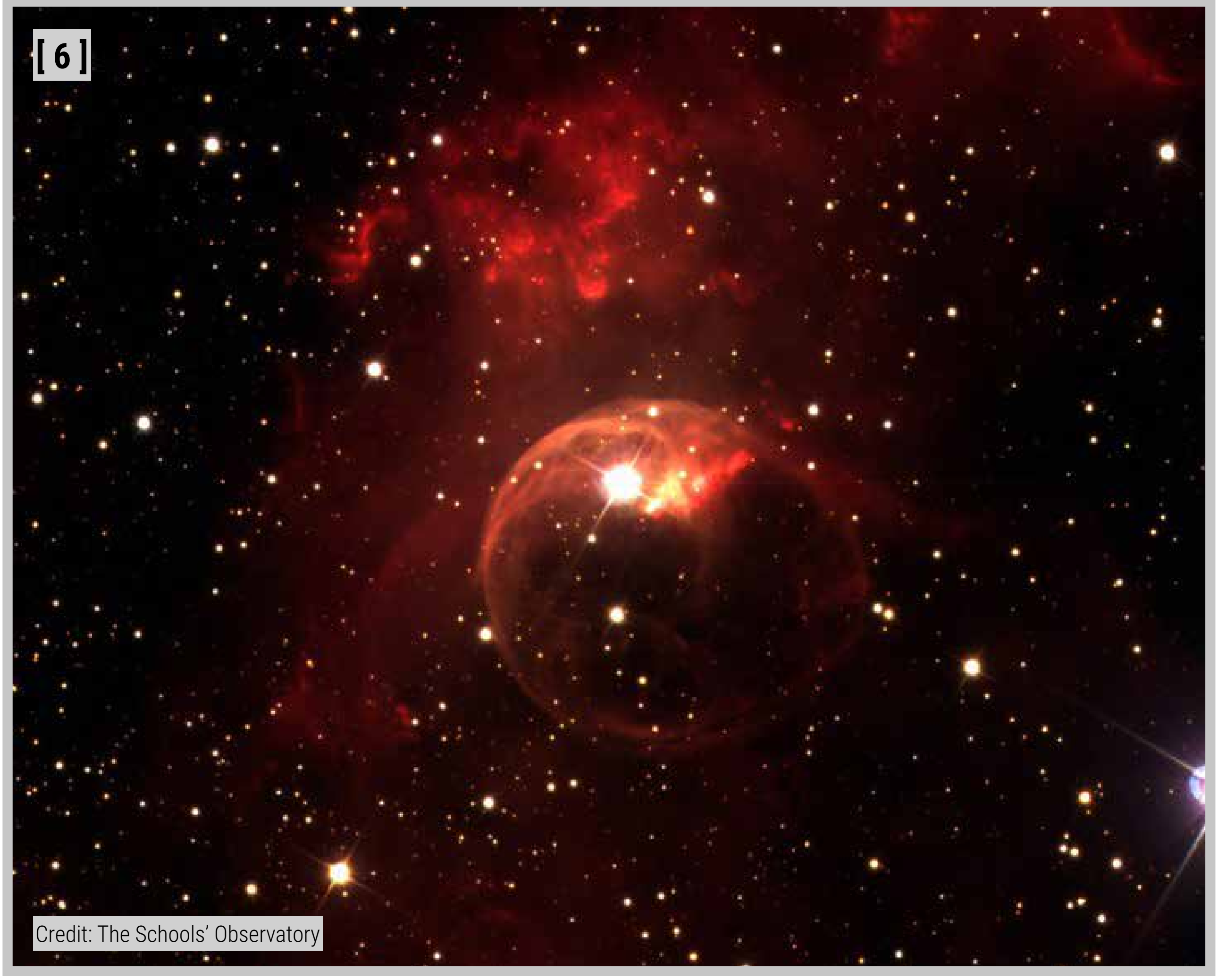
redit: NASA/ESA/Hubble



Credit: ESO

Credit: NASA,ESA,A.Fruchter(STScI), ERO (STScIST-ECF)


[5]
Credit: The Schools' Observatory


[6]
Credit: The Schools' Observatory

SESSION 4: ASTEROID HUNT

In this session the pupils will be learning how to hunt asteroids in observations taken by the Liverpool Telescope.

Learning Objectives, pupils will learn:

1. how to log in to websites
2. how to download files from a website
3. how to use astronomical software
4. how to blink through images to spot changes

Each group will require the following:

REQUIRED RESOURCES
☆ Computer instructions*
☆ Our free software**
☆ Access to computers

*The step-by-step instructions for the pupils can be found here:
www.schoolsobservatory.org/stem-club
You can either print them or display them on screen to the group.

** Our software is available as a free download from our website:
www.schoolsobservatory.org/get-started/view-images
LTImage can be installed on the computers you'll be using or run from a memory stick. AstroLab can be used directly in an internet browser on your computer. This will depend on your schools individual setup. Further information can be found on the website link above.

ACTIVITY 1: LOG IN TO OUR WEBSITE

Before the session:
Prior to the session you will need to create a teacher account on our website. When you have a teacher account you can then create pupil accounts for your group. You might have done this already in the Bronze level. It is a quick and easy process:

Registering for The Schools' Observatory:

- ☆ Go to www.schoolsobservatory.org/register
- ☆ Choose the option to 'Register as a Teacher'. You will need to complete a short registration form.
- ☆ Once you have registered an account, you can create pupil accounts under your login. This allows you to manage the pupil accounts yourself. You can create a full class set of pupil accounts in one go in the 'My Account' section when you are logged in.
- ☆ A full video tutorial of the process can be found here: www.schoolsobservatory.org/help/myaccount
- ☆ Keep a note of the pupil usernames and passwords

ACTIVITY 2: GET THE IMAGES

The pupils will download the first set of image files (4 out of 8 total) from our website. If you have no internet or poor download speeds you can download these in advance for the pupils to copy onto their computers.

www.schoolsobservatory.org/discover/activities/hunting_for_asteroids

Set 1	Set 2
ah-demo-1.fits	ahunt-10-1-1.fits
ah-demo-2.fits	ahunt-10-1-2.fits
ah-demo-3.fits	ahunt-10-1-3.fits
ah-demo-4.fits	ahunt-10-1-4.fits

ACTIVITY 3: OPEN AND VIEW THE IMAGES

When they first open the demo fits files, the images will mostly be black. The pupils will 'scale' the images to reveal more of the stars (and asteroids) details. The more they scale the image the lighter the background will look. The key is to find a good balance between a dark background and bright stars. Some observations will need more scaling than others. You might find the help videos on our website useful when using our software for the first time:

When using AstroLab:
www.schoolsobservatory.org/get-started/view-images/astrolab/nova-view

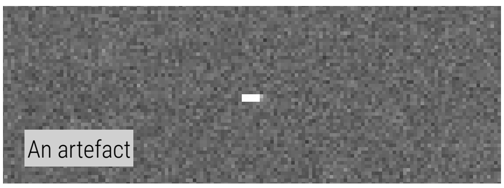
When using LTImage:
www.schoolsobservatory.org/get-started/view-images/ltimage/how-to

ACTIVITY 4: HUNT THE ASTEROID

Pupils will learn the method of 'blinking' by switching between images to find the missing object. The first set of images are simulated (the asteroid has been inserted artificially). You should see it in the top left quarter of the image (the red circle on the next page). It should be quite easy to spot and there are no other objects near it.

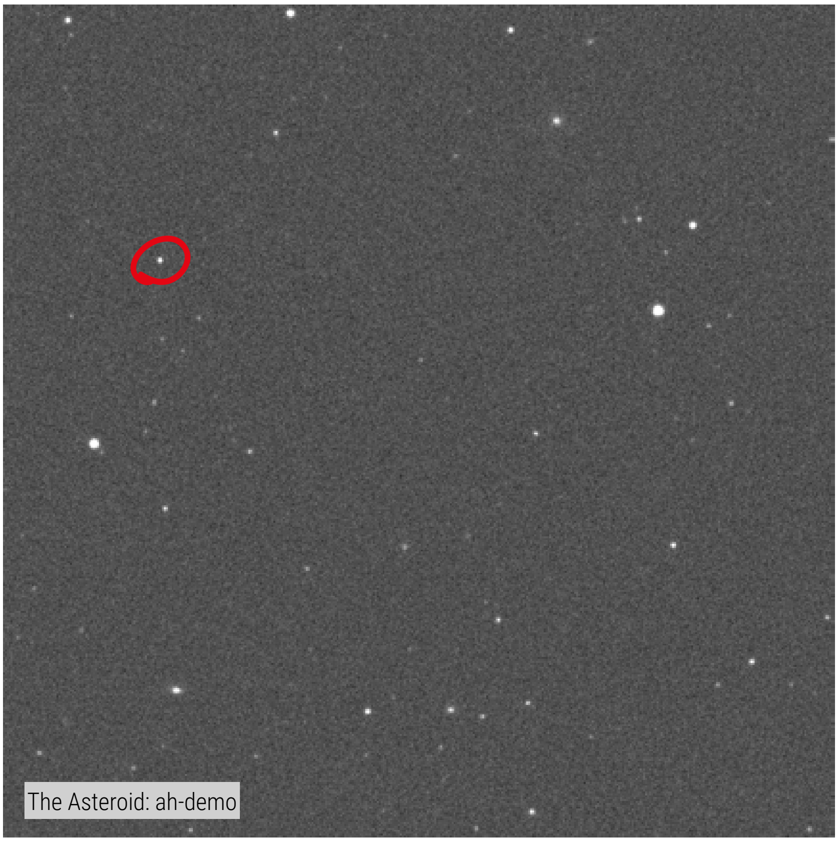
The stars can appear to 'wobble' slightly due to wind and telescope pointing variations. Asteroid movement is more obvious.

You might also notice a single spot of bright light on one of the images that isn't in the others. It is just an artefact of the camera. Artefacts look sharp, like in this example:



(Continued on next page.)

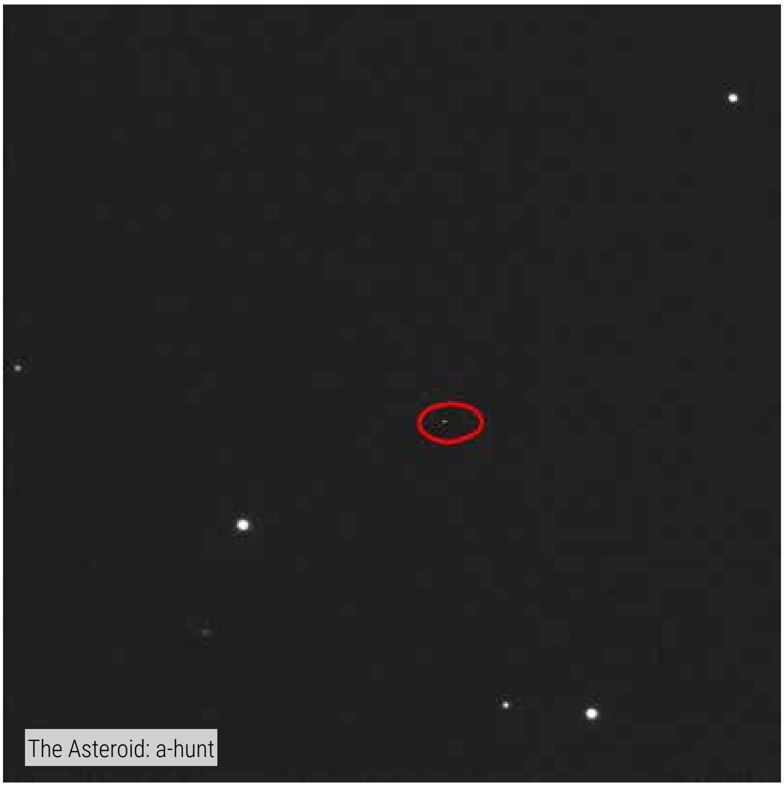
There is space in the pupils workbook to draw or paste a photograph of their asteroid. Ask them to circle the asteroid so they know where it was!



BONUS: FINDING OTHER ASTEROIDS

Pupils can repeat the activity on the second set of images (filenames starting "ahunt"). This second data set contains the real Liverpool Telescope images of asteroid NEO 2001 GQ2. Some asteroids may appear very faint in the image. They are far away, often very small, and can take a long time to spot. This is the reality of astronomy! It helps us work out if any could be "killer asteroids" so it's an important job!

Not all sets of files will contain a visible asteroid.



SESSION 5: THE MOON

ACTIVITY 1: MOONSAIC

Learning Objectives, pupils will learn:

1. pattern awareness and matching
2. to work as a team
3. to develop an understanding of the surface and features of the Moon

This week the pupils will put together a mosaic of the Moon using observations taken by the Liverpool Telescope.

Each group will require the following:

REQUIRED RESOURCES
☆ Print-outs of Moonsaic JPG file*
☆ Sticky Tape
☆ Scissors

*Download the **'Moonsaic - Full Moon'** zip file from: www.schoolsobservatory.org.uk/things-to-do/moonsaic

Before the session:
There are four other Moonsaics available to download on the same webpage. These show different phases of the moon and the Apollo landing sites. You can choose for groups to complete different Moonsaics during this activity, but make sure at least one group assembles the Full Moon because it is needed for the second activity.

There are 36 pieces to the Full Moon Moonsaic.

Print each 'Moonsaic' with the following settings: A4 or A3, single sided, do not scale the images to fit the page (you should be printing square Moon segments).

The Moon sections overlap a little, which makes it easier for your pupils to match them with other pieces and then stick them together. If you print out more than one set, mark the reverse side in some way to help you identify them.

During the session:
This activity helps to show the different surface textures seen on the Moon, with detailed images of heavily cratered regions alongside much smoother lunar seas (Mare). Shadowed craters and mountains show that the Moon is illuminated by the Sun.

Answers to 'fill in the blanks':

- ☆ The Moon is our **nearest** neighbour in space.
- ☆ The Moon **orbits** around the Earth.
- ☆ It takes **28** days to orbit the Earth.
- ☆ The Moon reflects light from the **Sun** (it does not create its own light).
- ☆ The Moon is the only natural place in space that humans have set foot on. The last Moon walk took place in the year **1972**.
- ☆ The surface of the Moon has dark and bright regions, mountain ranges and lots of **craters**.

Useful information about the Moon:

- ☆ It is a sphere despite us seeing a flat 2D circular disc in the sky.
- ☆ It is not a light source. The light areas on the Moon are areas where the Sun's light is reflected.
- ☆ It is hot. Its daytime temperature is +107 deg Celsius.
- ☆ It is cold. Its nighttime temperature is –153 deg Celsius.
- ☆ It is slowly drifting away from Earth at 4 cm per year.
- ☆ It is bigger than the dwarf planet Pluto.
- ☆ It is 4.5 billion years old.
- ☆ It is on average 384,400 kilometres from the Earth. By car that would be a non-stop 200 day "road" trip. If you drove at a steady 50 mph/80 kph for 24 hours a day.
- ☆ It is 81 times less massive than the Earth, and has 1/6th of the Earth's gravity.
- ☆ It orbits the Earth at an average of 3700 kilometres per hour.
- ☆ It has no atmosphere.
- ☆ The lunar 'seas' (Mare) are not really seas. Early astronomers mistook them for seas. They are really large, flat plains of rock.
- ☆ It causes tides on Earth (tide simulator: www.schoolsobservatory.org/things-to-do/why-does-earth-have-tides).

ACTIVITY 2: HOW BIG?

Learning Objectives, pupils will learn:

1. to appreciate the scale of the Moon and its features
2. pattern awareness and matching

Before the session:
Make photocopies of page 26 so that there is enough for one lunar feature per group. For advance groups you may wish to give them all the features.

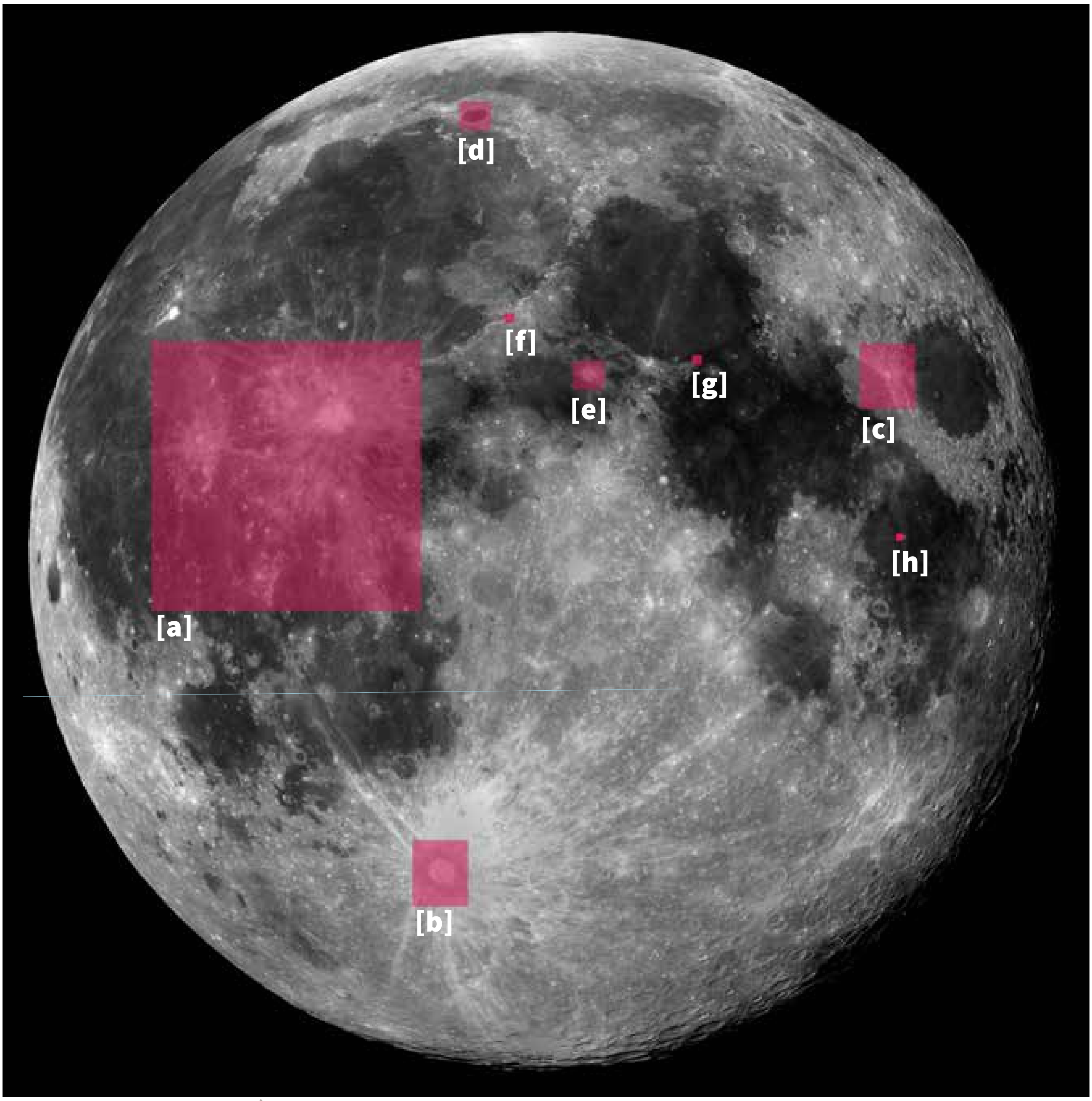
Each group will require the following:

REQUIRED RESOURCES
☆ Lunar feature cut-outs (page 26)
☆ Scissors

During the session:
Pupils will cut out their lunar feature and stick it in their booklet. They should then find their feature on the large Full Moon moonsaic from Activity 1. The answers are marked on the image below. The smaller features (f,g and h) are more challenging to find on the Moonsaic.

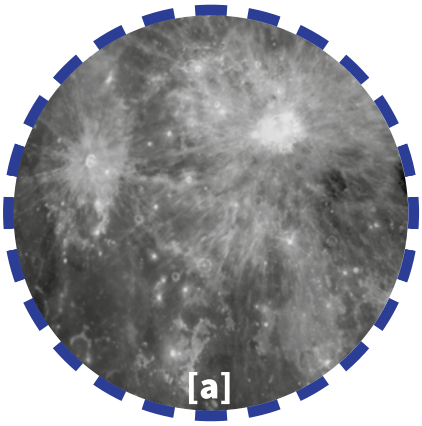
Once the pupils have found their feature, ask them to guess how big it is. There are 9 comparison objects in their booklets ranging from the size of a house at 5 m across to the size of the Earth at 13,000 km in diameter. Lead a discussion on how big they thought their lunar feature was and why. Are they surprised by the answers?

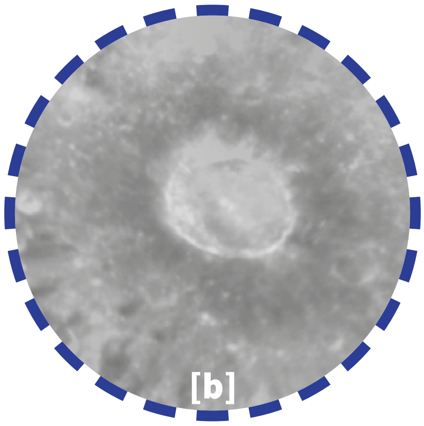
Lunar feature locations:

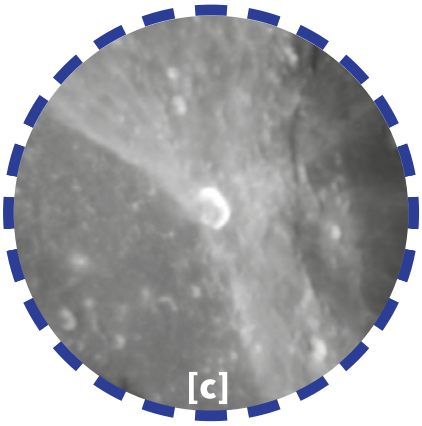


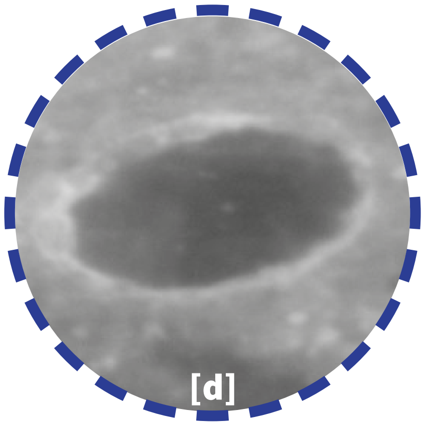
Some features are the same size. Some of the places on Earth are not used and will not match any of the lunar features provided.

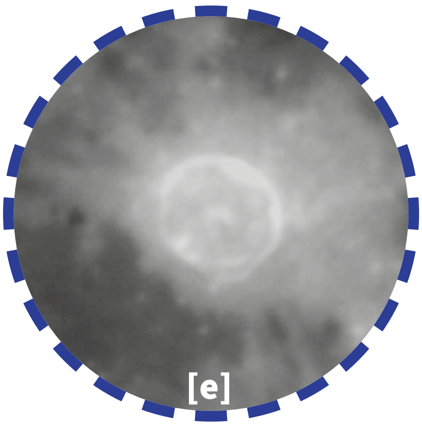
Lunar Features: Copy this page enough times so each group has at least one picture of a lunar feature. Cut them out.

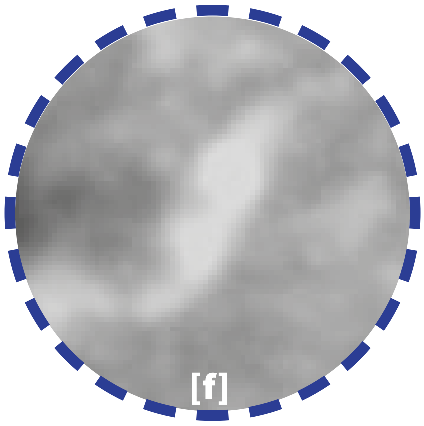


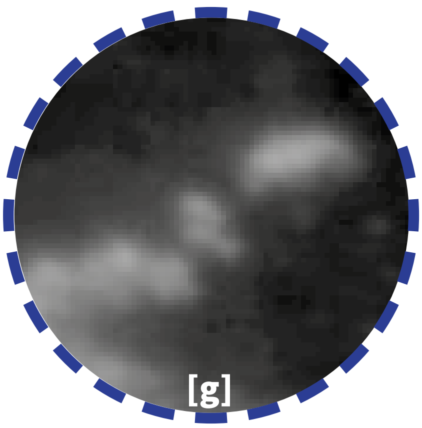


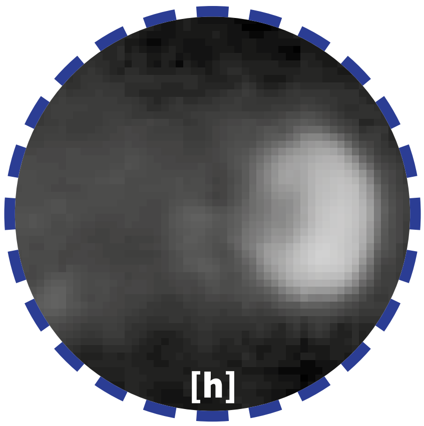




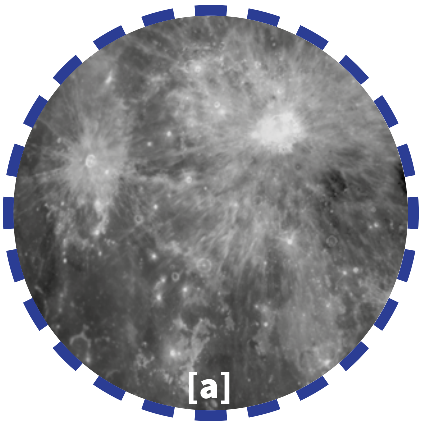






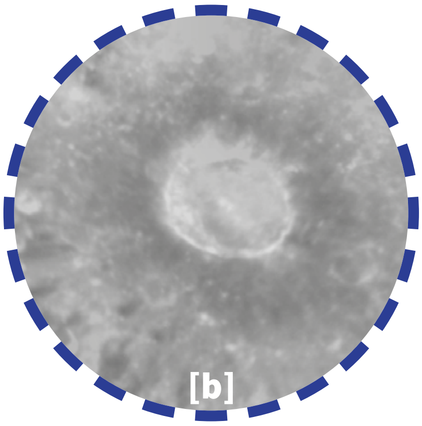


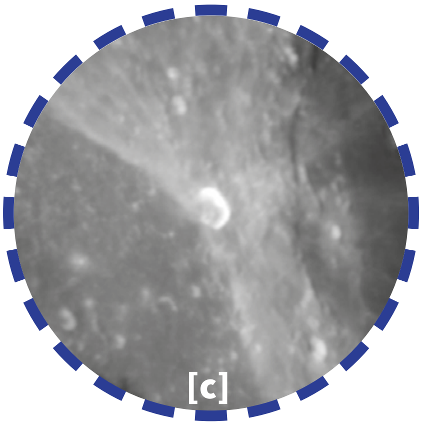
Lunar features with answers



[a]
Same size as UK & Ireland
Around 1000 km in diameter

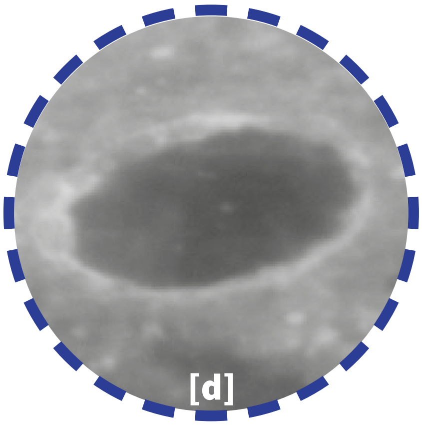
[b]
Same size as Wales
Around 250 km in diameter

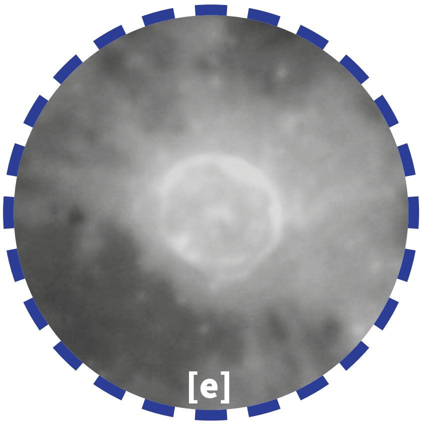




[c]
Same size as Wales
Around 250 km in diameter

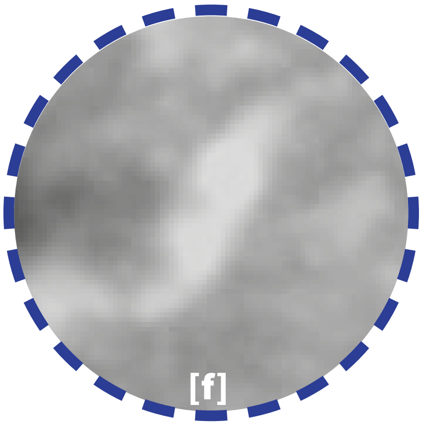
[d]
Same size as Cornwall
Around 120 km in diameter

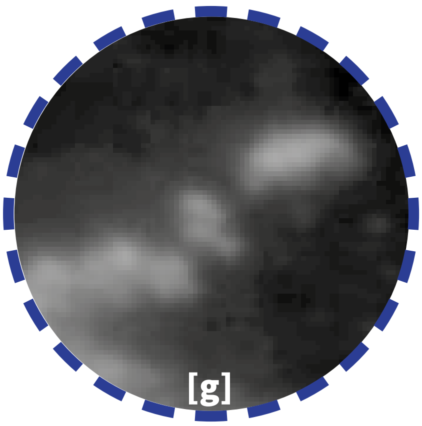




[e]
Same size as Cornwall
Around 120 km in diameter

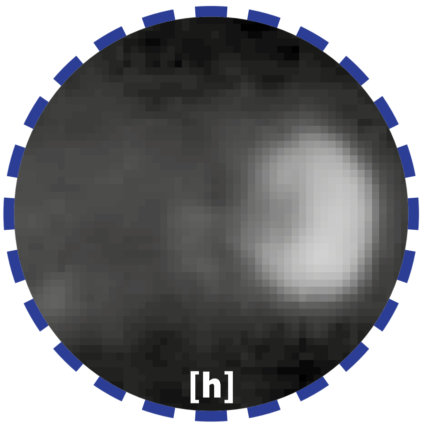
[f]
Same size as Loch Ness
Around 40 km in diameter





[g]
Same size as Loch Ness
Around 40 km in diameter

[h]
Same size as Guernsey
Around 25 km in diameter



SESSION 6: MISSION TO MARS

In this session, pupils will think about how to sustain life on Mars. What do humans need to survive on Earth and would it be any different or harder to provide these things on Mars?

Start the session with a whole group discussion of the general requirements for human life. Then you can split the pupils into small groups to design their Martian Base Camps.

Learning Objectives, pupils will learn:

1. what is needed to sustain life
2. the conditions on Mars
3. to design a mission

Before the session:
*The pupils can decorate their Martian Base Camps with any craft resources you may have. They can be creative e.g. use foil for solar panels, craft sticks for wind turbines etc. Or they can make a detailed sketch if not using the craft materials.

Each group will require the following:

REQUIRED RESOURCES
☆ A sheet of A3 paper
☆ Pencils/Pens
☆ Optional - creative materials*

During the session:
You should encourage pupils to think about what we need as humans to live. This includes the things we take for granted on Earth like clean water and shelter. Do we need all of these things on Mars and how could a base camp provide them? The pupils should label the elements of their base camp.

To help you we have created some talking points for the initial group discussion. You can continue to prompt the pupils with these questions throughout their design phase. The pupils have the same questions (bold) in their booklets.

How is Mars different to Earth?
Mars is smaller than the Earth and is about 11% of its mass. The gravity on Mars is only about a third of Earth's meaning that you could jump much higher. Mars is 50% farther from the Sun than the Earth. Mars receives about half of the sunlight we get on Earth but has much higher levels of harmful ultraviolet (UV) light and cosmic rays. The average surface temperature on Mars is about -60° Celsius but it can get as warm as 20° Celsius and as cold as –150° Celsius. It has a thin atmosphere primarily made of carbon dioxide.

What kind of shelters will we build?
Will the houses be like on Earth? Will they be in a large dome? Will people bring their families? Humans are messy creatures. We need sanitation, waste food disposal, cleaning etc. Where will the toilets be? Do you want them inside your habitation (potential smells?). The alternative is to separate the toilets from the main living space but how would you get to them? Use a space suit? Or a tunnel?

How can we get air to breathe?
Air is made up from about 21% oxygen, 78% nitrogen and the remaining 1% is made from a mixture of other gasses including, argon, carbon dioxide and methane.

The Martian atmosphere is made up of around 95% carbon dioxide, 2.7% nitrogen, 1.6% argon and about 0.13% oxygen, so we could have lots of plants or trees to absorb some of the carbon dioxide along with water and sunlight to produce oxygen for us.

However, some scientists working on the “Mars Oxygen In situ resource utilization Experiment” (or MOXIE for short) are using the fact that carbon dioxide is made of one carbon atom and two oxygen atoms to separate them and create air for humans.


rtist’s concept of Martian habitat By NASA

What will we eat and how will we prepare it?
Will there be meat and dairy on Mars? If so, how do we house, feed and transport the animals? Can we grow fruit and vegetables on Mars? Can we avoid food waste?

Where will we get water from?
Water is very heavy. It is therefore very expensive to transport it to Mars from Earth. Can you make it instead? Water is 2 parts hydrogen to 1 part oxygen (H_20). To make water you need to combine the two gases and ignite them with a spark. Watch out though! Hydrogen is very flammable so you would need to store it very carefully.

Is there any water on Mars? There is ice on Mars but you would need to extract it. It is a finite resource so you would probably want to recycle as much as possible.

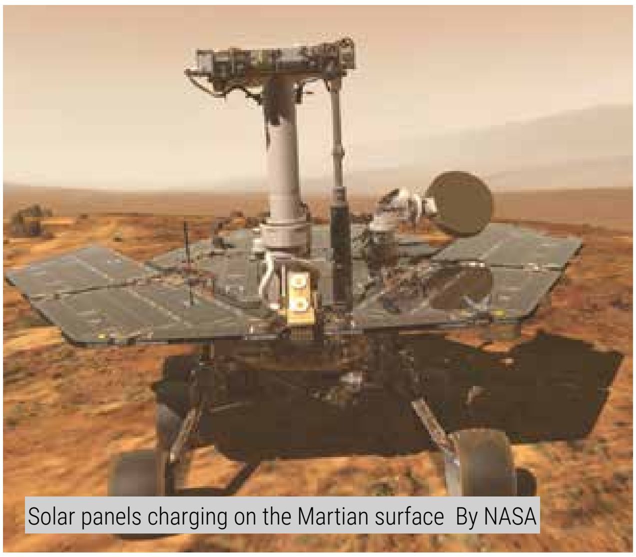
What can we do to relax?
It’s a long journey back to Earth, so we will need social spaces to make friends and to relax after a hard days work.

Where will we carry out experiments?
Scientists need to be able to carry on their investigations on Mars. Some experiments may be sensitive to contamination, or dangerous, or noisy. It is probably safest to separate them from the human habitats.

How can we explore the surface?
How large should transportation be? Do you want to travel around on your own in the empty Martian world? Large vehicles would be expensive to make. Would any transport be made on Earth or built on Mars? If so where do you get the parts from?

How can we communicate with each other on Mars and the people back on Earth?
People tend to get homesick so it would be nice if they could communicate with their friends and family back on Earth.

You will also need help from Mission Control so it is important to have a stable communication system. This could be done using satellites.
The delay when communicating between Earth and Mars is between 4 minutes and 24 minutes depending on the position of the two planets at the time. So saying “Hello, how are you?” and hearing a response could take up to 48 minutes!


Solar panels charging on the Martian surface By NASA

At the end of the session:
Take photos of each group’s base camp so the pupils can stick a printed photograph in their own workbook.

If you share any photos on social media you can tag us with **@SchoolsObs**.

JUST FOR FUN: BUILD A SOLAR VIEWER

Pupils will use everyday items to construct a simple solar viewer. Creating a pinhole viewer is a safe way to view the Sun or solar eclipse. The solar viewer will produce a small circle of light on the screen. This is not just "light", it is an upside-down image of the Sun.

Learning Objectives, pupils will learn:

1. how to safely view the Sun
2. to understand why it is unsafe to look directly at the Sun
3. to follow instructions to construct a pinhole viewer
4. to recall and describe what they observe

*This activity works best on a sunny day, but you can test your setup with a lamp or torch held far away.

Each group will require the following:

REQUIRED RESOURCES
☆ The Sun*
☆ 2 pieces of white paper/card
☆ Aluminium foil
☆ Tape
☆ Pin/needle/paper clip
☆ Scissors

Before the session:
Make sure you have all the required resources. Discuss the safety of looking at the Sun or observing an eclipse with the group. Ensure pupils understand that they must not look directly at the Sun because the Sun's rays will burn the back of the eye and can cause blindness.

During the session:
Provide any assistance pupils need while they are constructing or using their pinhole viewers. Encourage pupils to read the instructions carefully and use the tips in their booklet to get the best image.

The solar viewer is weather dependent so you might want to check the weather and do this when you get a clear sunny day!

NEXT STEPS...

Congratulations on completing the Silver level of The Schools' Observatory STEM Club!

We hope your pupils have enjoyed the last six weeks and are proud of their completed workbooks. You will notice that the final page of their workbooks contains a space for their certificate. To obtain your certificates, please complete this short online form:

www.schoolsobservatory.org/stem-club/certificates

Once you submit the form, you will be able to download your certificate.

You can access the Gold level booklets here: www.schoolsobservatory.org/stem-club

Thank you for being part of The Schools' Observatory Club!

JUST FOR FUN

We love to see the images that pupils have created from their observations! On page 18 of the pupil booklet there are details on how to share pupils' astronomical observations with us. The images you share with us may be showcased in our Galleries on The Schools' Observatory website.

You can share pupils' images with us by:

- ☆ Tagging @SchoolsObs on Twitter or Instagram

By sharing pupils' images with The Schools' Observatory, you consent for us to use those images on our website and social media accounts and/or for publicity.

FEEDBACK

We love to hear from our users about how we can improve our services. If you or your pupils have ideas about how we can improve these booklets please email SchoolsObs@ljmu.ac.uk

THE SCHOOLS' OBSERVATORY

For more lesson ideas and interactive workshops visit the 'Things to Do' section of our website.

WWW.SCHOOLSOBSERVATORY.ORG/THINGS-TO-DO

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STEM Club

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